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Explaining students' mistakes using concepts from psychology

Psychology, and in particular visual perception, can offer explanations for students' mistakes in geography. The purpose of this article is to illustrate, using examples, some of the ways in which this occurs.

Cartographers use concepts drawn from psychology in the production of maps. For example, the colours chosen for layer tints on relief maps are based on a physiological effect known as 'advance and retreat'. The theory suggests that, when visible light passes into the eye, it inversely refracts relative to its wavelength, so that longer wavelengths, i.e. those at the red end of the spectrum, appear closer than shorter wavelengths, i.e. blue. On relief maps, therefore, hues at the red end of the spectrum are often chosen to depict high elevations and blue and green are employed to depict lower ground, creating a sense that the mountains rise up from the plains.

However students make mistakes in interpreting maps. Identification and correction of perceptual errors is important because, once embedded, they are often difficult to erase and frequently lead to other misconceptions.

Locating places

Many students believe that London is at the same latitude as New York. In reality London, at 51° 30' N, is much further north than New York, which is located at 42° 40' N. Tversky (1981) suggests the reason for the error is that Europe is frequently aligned with North America, which encourages the belief that Europe is further south than it really is. Similarly, Africa is often aligned with South America, which encourages students to think that the Equator runs through the Sahara.

Places are also mentally aligned along a north–south axis. For example, Spain is often viewed as due south of Britain, whereas in fact it is slightly positioned to the south-west. Similarly, the island of Sri Lanka is often perceived as being aligned with the southern tip of India whereas it is actually to the east.

Figure 1: Europe is frequently aligned with North America which can lead students to think that Europe is further south than it really is.
Photo: Barking Photographic.

The vertical and the horizontal occupy a privileged status in perception and language, in that we often compare objects with the horizon, or with upright figures. These orientations are therefore useful in helping us to fix and remember locations. The tendency to align positions in this way is known as an **alignment heuristic** and is one source of error in locating places.

A related idea is the **rotation heuristic**, which is the tendency to mentally rotate a tilted object so that it is more vertical, or horizontal, than it really is. Britain, for example, is often remembered as more upright than it really is, which consequently leads many students to believe that Edinburgh and London are on the same longitude, whereas in reality Edinburgh lies further west than London. Similarly, students often mentally rotate South America and as a result find it difficult to believe that Santiago in Chile is located east of New York (Tversky, 1981).

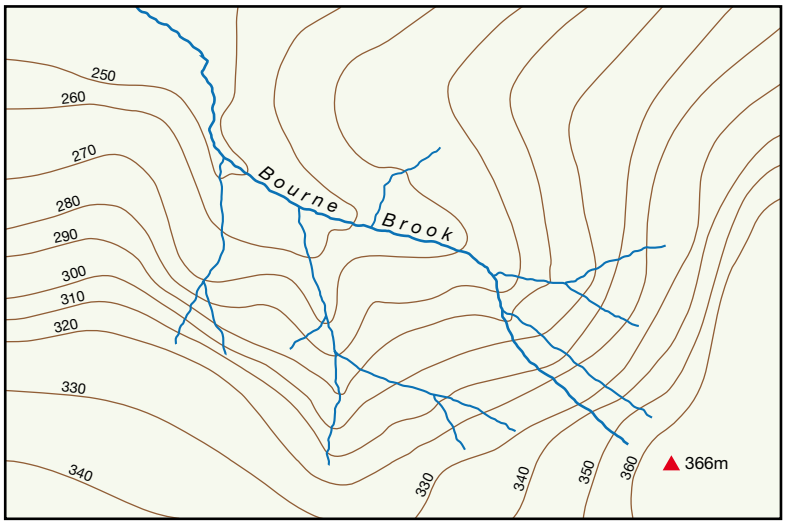

Figure 2: Test question: 'In which direction is the river flowing?'

Distinguishing land from sea

Students often have difficulty distinguishing seas such the Mediterranean from the surrounding land areas. The problem of distinguishing an object or figure, which in this case equates with land, from its background or ground as it is known, i.e. the sea in this example, is one of the fundamental organisational concepts in visual perception. According to **Gestalt theory** a figure is distinguished from its ground when it is enclosed, or is the smaller of the two areas, or has a vertical or horizontal alignment, or has good continuation. The problem in the case of the Mediterranean, which is almost an enclosed sea, is that it looks like a figure which makes it difficult to distinguish from the surrounding land areas. For a further discussion of the problems of distinguishing sea from land see MacEachen (1995).

Interpreting contours on relief maps

Ideas about figure and ground may also explain why some students have difficulty interpreting contour lines on relief maps (Wiegand and Stiell, 1997). One problem is that contours produce open rather than closed patterns, which makes it difficult for students to distinguish figure from ground. The difficulty this creates was demonstrated in a study by Boardman (1985) in which students, when asked to shade an area on a simple contour map below 91 m, shaded only the area between this and the next contour line, which was 76 m, and ignored the land below this line.

A further reason why students have difficulty interpreting isarithms such as contour lines relates to Gibson's texture gradient theory. The theory suggests that, in visual images, textures which become finer and smoother as they recede into the background create a sense of depth. Lines, for example, which are drawn finer and closer together as they approach the horizon create a sense of perspective. This concept may, however, create a false sense of depth on relief maps which contain closely-spaced contours. It was, for example, one reason offered for the difficulty students encountered in interpreting convex and concave slopes in a study by Griffin and Lock (1979).

Rivers flowing south

The belief that rivers, when drawn on paper, flow towards the base of the page is deeply engrained. It is difficult to conceive of water, a liquid, flowing anywhere but downwards, which is why many students have difficulty believing the River Nile flows up the page. Western cultures also read from the top to the bottom of a page, which further reinforces the concept of downward motion. The belief that rivers flow downwards, together with the convention that most maps place north at the top of the page, frequently leads to mistakes in map interpretation. For example, despite the presence of contours, the author has observed that many students, when asked in a test to identify the direction of river flow in Figure 2, will suggest south-east, rather than north-west.

Colour on maps

Colour symbolisation and emotional responses to colour have been major areas of research in psychology. Red is associated with heat, dryness and danger; blue is linked to cold and wet conditions; and green to lushness and fertility (Patton and Crawford, 1978). Blue, unsurprisingly therefore, is the colour conventionally chosen to depict rivers and water bodies, but such a strong association can sometimes lead to misconceptions. Some students, for example, literally believe that rivers are blue (Dove et al., 2000). Another problem is that motorways, which are also coloured blue on 1:50,000 Ordnance Survey maps, are often mistaken for rivers, but the reverse is rarely the case.

The choice of colours selected for the layer tinting on relief maps, as mentioned at the beginning of the article, can also be a source of misinterpretation (Patton and Crawford, 1978). The colour green, for example, which is used to show low elevations, is often misinterpreted

Figure 3: Motorways can be mistaken for rivers on 1:50,000 Ordnance Survey maps. **Photo:** Shaun Flannery.

as lush grassland, while light brown or yellow is believed to represent sparse vegetation and aridity rather than low relief (Wiegand, 2006).

Estimating distances

When asked whether Newcastle-upon-Tyne or Brussels is closer to London, many students would probably incorrectly suggest 'Newcastle'. The explanation for the error again links to Gestalt theory, which suggests that two points located within one figure, in this case Britain, are more likely to be perceived as closer together than two points in separate figures, i.e. Britain and Belgium.

Matlin (2002) suggests that estimating the distance between two points is influenced by three factors, namely the number of intervening cities, semantic categories, and whether the points are landmarks or non-landmarks. Where there are no intervening cities between two points, the distance is perceived as shorter than it would be if, for example, there were four intervening cities. It is for this reason, similarly, that people tend to overestimate distances in urban areas such as London, where there lots of landmarks along the route. Two locations which are semantically close – for example, two churches – are also often perceived as closer together than, for example, a church and a swimming pool. Travelling to an important, large or distinctive landmark from a smaller, less significant non-landmark also appears to be shorter than the converse. For example, travelling to London from a rural village in Oxfordshire may well appear to be shorter in terms of distance than journeying in the opposite direction.

Conclusion

This article has illustrated how findings from cognitive psychology can offer explanations for students' mistakes in geography. Psychology is a popular subject and students are likely to take an interest in the reasons for their mistakes. Moreover, raising their awareness of the connections between visual perception and geography may encourage students to identify further links between the two areas.

There is considerable scope for further research into how theories of visual perception relate to geography. For example, are river meanders perceived as more symmetrical, and roads straighter, than they really are? How do main roads and rivers distort estimations of the distances between places located on either side of these barriers? Are road junctions perceived as intersecting more at right angles they do in reality? On a 1:25000 map, are red symbols some of the first to be noticed by students? Are the blue tourist symbols – for example for nature reserves – always associated with water features? Answers to such questions may help to arrest perceptual errors which, left unchecked, could persist into adulthood. | **TG**

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Glossary

Gestalt theory: a psychological approach that identifies a number of laws of organisation underpinned by the idea that the whole is greater than the sum of its parts.

Heuristic: a general rule or strategy for solving a problem.

Alignment heuristic: a series of figures which are remembered as being more aligned than they really are.

Rotation heuristic: a tilted figure which is perceived as more vertical or horizontal that it really is.

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